REMARKS

Applicant thanks the Examiner for the careful review of this application. Claim 1-27 were previously canceled without prejudice. Claims 28, 34, 38, 40-41 and 47-50 were amended to clarify the claimed embodiments. New claims 55-60 were introduced for consideration. No new matter was added. Therefore, claims 28-60 are currently pending in this application.

RELATED APPLICATIONS

Applicant notes for the record that the present patent application is related to U.S. Patent Application No. 10/627,185, entitled "Cleaning Process and Apparatus for Silicate Materials", filed on July 24, 2003 (Attny Docket No. 59081-8009.US01).

REJECTIONS UNDER 35 U.S.C. § 103(a)

Claims 28, 30, 33-34, 36-41, 43-45 and 48-52 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Uehara (U.S. Patent No. 6,767,840) in view of Balconi-Lamica (U.S. Patent No. 5,516,399) and further in view of Dryer (U.S. Patent No. 6,187,216). Claims 29 and 42 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Uehara in view of Balconi-Lamica, Dryer and Leibovitz (U.S. Patent No. 5,221,421). Claim 31 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Uehara in view of Balconi-Lamica, Dryer and Kaji (U.S. Patent No. 4,980,017). Claim 32 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Uehara in view of Balconi-Lamica, Dryer and Sheng (U.S. Patent No. 4,579,569). Claim 35 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Uehara in view of Balconi-Lamica, Dryer and Meek (U.S. Patent No. 3,775,202). Claims 53-54 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Uehara in view of Balconi-Lamica,

Dryer and Lee (U.S. Patent No. 5,891,354). Applicant respectfully traverses for the following reasons.

PRIOR ART SUMMARIZED

Uehara apparently discloses an ultrasonic bath that is arranged below a wafer processing bath. Wafers are processed while ultrasonic waves are transmitted from the ultrasonic bath to the wafer processing bath (10). The wafers are processed while being entirely dipped into the wafer processing bath and rotated by wafer rotating rods.

Balconi-Lamica apparently discloses a contactless method and apparatus for real-time in-situ monitoring of a chemical etching process for the etching of at least one wafer in a wet chemical etchant bath. The method comprises the steps of providing at least two conductive electrodes in the wet chemical bath, wherein the at least two electrodes are proximate to but not in contact with the at least one wafer, and further wherein said two electrodes are positioned on the same side of the wafer. Also included is monitoring an electrical characteristic between the at least two electrodes, wherein a prescribed change in the electrical characteristic is indicative of a prescribed condition of the etching process.

Dryer apparently discloses a wet etch bath that holds a wet etchant for etching a dielectric over a semiconductor substrate. The wet etch bath has a tub separated from a reservoir by a wall. The tub is filled with the wet etchant to a height of the wall. The reservoir is filled with the wet etchant to a height less than the height of the wall. A pump coupled to the reservoir pumps the wet etchant through an osmotic membrane de-gasifier to the tub. Adding the wet etchant to the tub causes the wet etchant to cascade over the wall back to the

reservoir. The osmotic membrane de-gasifier will perhaps reduce a concentration of a reactive agent in the wet etchant.

Leibovitz apparently discloses a specialized etching method for producing fine-geometry gold circuit structures. Production thereof is perhaps accomplished by maintaining a constant gold etching rate. Metal etching normally slows as the amount of dissolved gold (a reaction product of the etching process) increases. To remove the dissolved gold, one method involves cooling the etchant to precipitate a gold complex therefrom. The remaining, recovered etchant is then heated and made available for continued etching. Another method involves a cathode/anode assembly which is immersed in the etchant. Activation of the assembly recovers metallic gold and regenerates the etchant. These methods, when used continuously or periodically in a dip or spray etching system, will perhaps maintain a constant etching rate.

Kaji apparently discloses a method for re-circulating a high-temperature etching solution. The method includes the steps of continuously removing, from a bath for etching a wafer for a semiconductor device, a portion of an etching solution contained in the etching bath, injecting a predetermined amount of pure water for adjusting the concentration of the etching solution into the removed etching solution, heating the resulting solution to a predetermined temperature, and re-circulating the heated solution into the etching bath.

Sheng apparently discloses method for neutralizing acidic fumes and basic fumes. First, the acidic fumes and basic fumes are mixed in a nontoxic carrier gas. The carrier gas is essentially non-reactive with the basic and acidic fumes at least under a required operating condition. Then, an upward swirling accelerated

motion is imparted to the carrier in such a manner as to cause closer contact of, higher concentration of, and higher rate of neutralization of the basic and acidic fumes, thereby forming a salt. Next, a solvent for the salt is sprayed downwardly onto the upwardly moving carrier to dissolve the salt in the solvent. The solvent is heavy enough to fall. The fallen solvent is collected and the carrier is exhausted into the atmosphere.

Meek apparently discloses an etching system that utilizes a ferric chloride solution or equivalent spray that is directed onto copper work pieces to be etched. The etchant in the etchant sump is circulated through a chlorinator under the control of an etching control monitor. This introduces gaseous chlorine and will perhaps maintain the etching potential of the ferric ions present in the solution. As copper accumulates in the etchant, ammonium chloride is added and this mixture is cooled. A crystallized double salt containing copper is separated and the solution reduced of the copper content is stored for subsequent re-introduction into the system.

Lee apparently discloses A method of etching through a wafer from a first surface thereof to a second surface thereof using a liquid chemical etchant, said wafer having a plurality of electrical traces formed at its second surface and overlying an area of the wafer which is to be etched away by said method, the traces are to be protected from exposure to the liquid chemical etchant. The method includes the steps of forming on each wafer surface a layer of material which is etch-resistant to the liquid chemical etchant before the electrical traces are formed and forming over said etch-resistant layer at said second surface a layer of polymeric material before the electrical traces are formed. A portion of said etch-resistant layer is then removed at said first surface and after the

electrical traces are formed, exposing said wafer to the liquid chemical etchant such that said etchant does not contact the electrical traces at the second surface of the wafer.

PRIOR ART DISTINGUISHED

Aspects of the claimed embodiments are directed to a method for ultrasonically chemically etching a workpiece. The method includes providing inner and outer tanks such that an etchant is contained in the inner tank and the outer tank contains an aqueous solution and the inner tank is partially submersed in the aqueous solution. The inner tank also has a lid to increase the partial pressure above the etching solution. The method also includes ultrasonically agitating the etching solution using an ultrasonic transducer coupled to the outer tank and not in the aqueous solution. Fig. 3A and a passage describing the transducer are provided here for the Examiner's convenience:

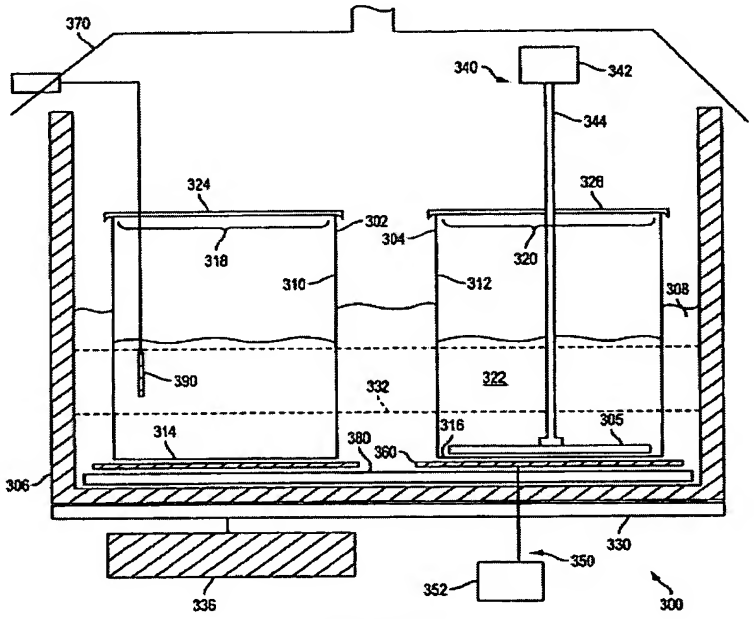
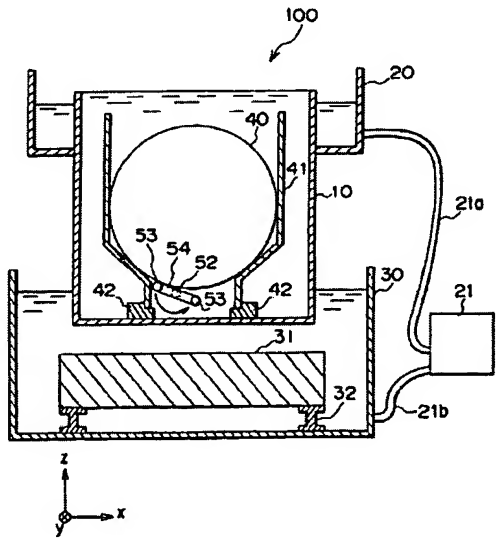


FIG. 3A

"Apparatus 300 also includes an ultrasonic transducer 330 which is coupled to power oscillator 336 and outer tank 306 such that it imparts ultrasonic energy to etching solution 322 in inner tanks 302 and 304. The ultrasonic transducer agitates chemical solution 322 through aqueous solution 308 to accelerate the etching of workpiece 305. In the embodiment shown, the ultrasonic transducer is positioned outside of the aqueous solution. However, in another embodiment, the transducer is positioned within the aqueous solution. A plurality of ultrasonic

transducers may be employed, if desired, as described, e.g. in U.S. Patent No. 6,181,052 (Jan. 30, 2001), entitled "Ultrasonic generating unit having a plurality of ultrasonic transducers," which is incorporated herein by reference. Ultrasonic transducers may be purchased commercially from a number of sources such as Branson or Misonix (www.misonix.com). Methods for controlling various frequency ranges of ultrasonic energy are described in U.S. Patent No. 6,433,460 (Aug. 13, 2002), which is incorporated by reference herein. Ultrasonic energy is typically between 25-40 kHz or greater. However, the energy may be adjusted as desired depending on additional parameters as discussed above. Ultrasonic power typically ranges from 30-50 watts/gallon, but may also be varied to include powers that are less or greater than this range." – Applicant's specification, page 12, line 27 - -page 13, line 8.

Applicant respectfully submits that Uehara does not disclose an ultrasonic transducer not in the aqueous solution. Instead, Uehara discloses an transducer contained in the aqueous solution as can be seen in Uehara's Fig. 2:



Uehara's transducer 31 resides inside the aqueous solution and is coupled to the outer tank by ultrasonic source 31. Advantageously, having the transducer outside of the aqueous solution prevents the transducer from corroding due to contact with the solution. Additionally, the transducer can potentially be a source

of particles. Having the transducer outside of the aqueous solution prevents contamination from occurring.

Regarding claims 28, 33 and 34, the Examiner has stated that the transducer is equivalent to Uehara's 31 for claim 1, in claim 33 Uehara's 31 is made equivalent to an ultrasonic buffer and in claim 34, Uehara's 32 is said to be the same as Applicant's transducer. Applicant is therefore unclear as to what the Examiner considers to be the transducer and the buffer in Uehara. Clarification is respectfully requested.

Regarding Dryer, Applicant respectfully submits that Dryer's covering does not increase the partial pressure above the etching solution. While Dryer's lid seals the top of the inner tank, there is an inert gas feed present on a side of the tank. As a result, the inner tank is not fully sealed due to that extra opening. This is further evident by reviewing Dryer's Figs. 2-3 and relevant descriptive text:

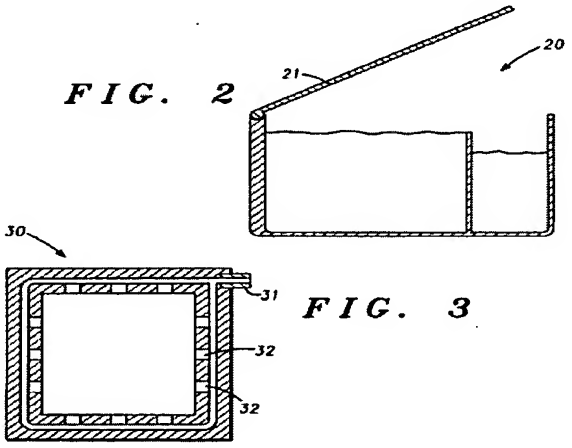


FIG. 3

"FIG. 2 is an illustration of a lid 21 attached to wet etch bath 20 in accordance with one aspect of the present invention. Lid 21 seals wet etch bath 20 from the ambient. A non-reactive (or inert) gas such as nitrogen is sprayed across the surface of the etchant to prevent oxygen diffusion into the etchant. It should be understood

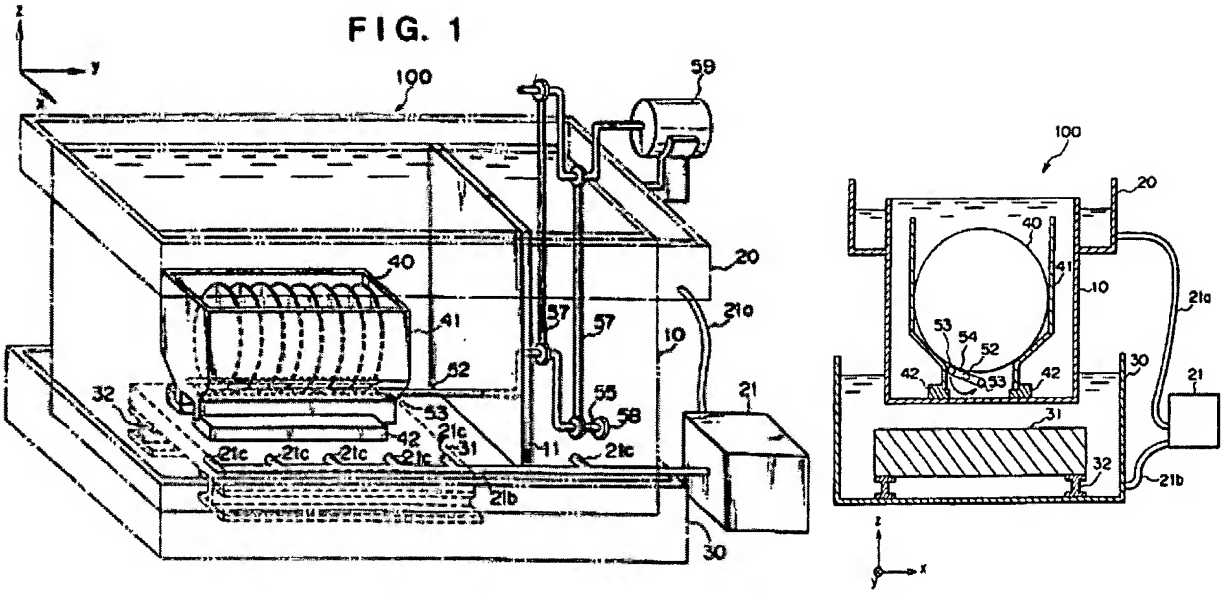
that when a non-reactive gas such as nitrogen is dissolved in the etchant, it does not affect the process of etching a dielectric.

FIG. 3 is a top view of a wet etch bath 30 illustrating an example of a means for spraying non-reactive or an inert gas across the surface of the wet etchant in accordance with another aspect of the present invention. In the example, the spraying means is a tube 31 having openings 32. Tube 31 is placed around the periphery of wet etch bath 30. Openings 32 spray the non-reactive gas across the entire surface of the etchant to minimize contact with the ambient. Examples of non-reactive gases are nitrogen, carbon dioxide, helium, neon, argon, krypton, and xenon. These non-reactive gases will not react with the semiconductor or other materials on a semiconductor wafer should they become dissolved in the etchant." – Dryer, column 4, lines 58 – column 5, line 11.

Since Dryer does not disclose a sealed inner tank, Applicant respectfully submits that Dryer does not disclose this aspect of the claimed embodiment.

Regarding amended claim 38 and dependent claim 39, Uehara does not disclose that the inner tank material is high-density polyethylene and it also does not disclose that the inner tank generates less than 10 ppb of leachable metal contaminants and 10 ppm of leachable anionic and organic contaminants. Similarly for new claim 60 does not disclose that a fluorine resin type material has similar limited contamination features. Additionally, Applicant respectfully points out that Uehara's particle reduction efforts are due to the way etchant is introduced into the inner tank in relation to the crank 55 that indirectly turns the wafers. This can be seen by studying Uehara's Figs. 1-2 and related description as follows:

FIG. 1



"However, particles produced on the crank 55 side may flow to the wafer 40 side through the bearing portion 11a, or particles may be produced at the bearing portion 11a.

For this reason, the wafer processing apparatus 100 circulates the processing solution upward from the bottom portion of the wafer processing bath 10 by arranging supply ports 21c for supplying the processing solution to the wafer processing bath 10, near the bottom portion of the wafer processing bath 10. Further, by arranging many supply ports 21c on the wafer 40 side, the wafer processing apparatus 100 adjusts the flowing direction of the processing solution so as to prevent the processing solution on the crank 55 side from flowing to the wafer 40 side. Accordingly, contamination of the wafers 40 by particles produced on the crank 55 side can be reduced.

The wafer processing apparatus 100 can also employ another means for preventing contamination of the wafers 40 by particles. For example, it is suitable to adjust the diameter of each supply port 21c." – Uehara, column 8, lines 45-64

Crank 55 (not shown in either Figs. 1 or 2) is coupled to rotating shaft 52. As rotating shaft 52 turns the wafers, particles will probably be produced due to

friction between the shaft 52 and the wafers in the boat. To prevent the particles from being directed to the wafers, supply ports 21c are supplied on the opposite side of the shaft as can be seen in Fig. 1. Contamination can further be inhibited by adjusting the diameter of the supply ports. For example, making the diameter smaller will result in a more forceful flow and thus more particles will be blown away from the wafers.

Amended claim 50 specifies that a horizontal cross section of the inner tank is substantially similar to a horizontal cross section of the workpiece. If one takes a vertical cross section of a wafer, that cross-section will be substantially the same as a horizontal cross section of Uehara's inner tank – in this instance a rectangular shape. However, a horizontal cross section of a wafer will be substantially the same shape of that wafer (a more or less circular shape) and therefore not the same shape as that of a horizontal cross section of the inner tank.

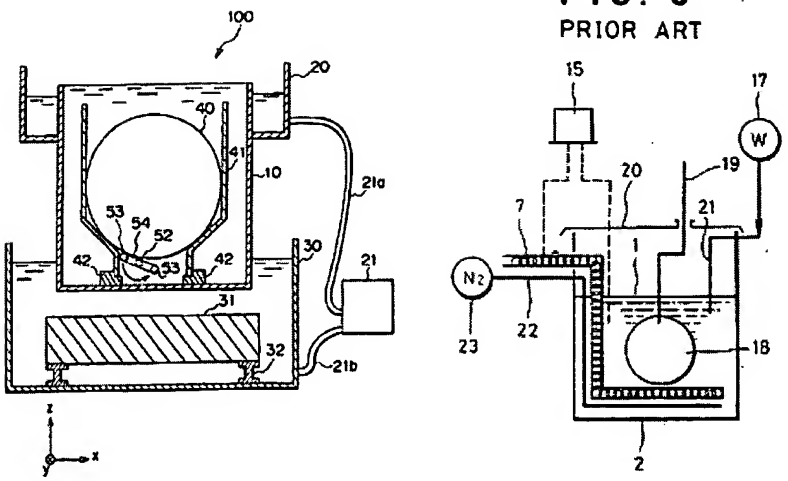
Claim 42 discloses the claimed embodiment of the aqueous solution in the outer tank is maintained at 20-50 degrees C. Applicant respectfully submits that Leibovitz does not disclose this particular embodiment. Instead, Leibovitz discloses that the etchant in the inner tank should be maintained at 30-50 degrees C. by heating the water in the outer tank to an unspecified temperature. Additionally, Applicant respectfully submits that it is coincidental that Leibovitz discloses the overlapping temperature range of 30-50 degrees C. That is, one can not simply find a temperature range from one reference and apply it blindly to a given process as the chemicals being used and the material being etched are obviously important factors to consider in conjunction with a temperature range. With that in mind, Applicant further submits that one trying to solve

issues that the claimed embodiments address would naturally not look to Leibovitz. Leibovitz discloses an etchant and process parameters for controlled etching of fine-geometry gold circuit structures. The claimed embodiments, on the other hand, are directed to the bulk cleaning of workpieces. Thus, super-fine control of etching parameters to achieve bulk cleaning of workpieces is not necessarily a requirement.

Speaking in general, there may be similarities between the claimed embodiments directed to the cleaning of large, geometrically complex workpieces and processes and equipment used for fine-pattern etching to construct devices on silicon wafers and the like. However, Applicant respectfully submits that they are just that – similarities. Therefore, the teachings of references applying to the etching of wafers to achieve fine dimensions need to be carefully reviewed before they can be applied to the etching and cleaning of large tool components.

For claim 31, the mechanism that produces the relative motion between the workpiece and the transducer is a rod that extends through the lid and is coupled to the workpiece. An attempt to combine Urehara's mechanism and Kaji's rod could result in the physical destruction of the workpiece as can be seen by reviewing Urehara's Fig. 2 and Kaji's

FIG. 3
PRIOR ART



The Examiner suggested that it would be obvious to combine Kaji's wafer holder 19 with Uehara's mechanism / rotating shaft 52 that rotates the wafers as they sit in the wafer boat 41. By sticking the wafer holder 19 to the top of wafer 40, the wafer 40 would be held firmly in place while shaft 52 attempts to rotate the wafer 40 from the bottom. As a result of these opposing forces, the wafer 40 being held on top and the shaft trying to rotate the stationary wafer 40, the wafer 40 could very likely break. Since this combination would damage the wafer / workpiece, one would tend to not combine Uehara with Kaji to achieve relative motion between a workpiece and a transducer.

In view of the foregoing, Applicant respectfully submits that Uehara in combination with the cited prior art does not disclose the claimed embodiments. Withdrawal of the rejections of claims 28-54 is respectfully requested.

ALLOWABLE SUBJECT MATTER

Applicant thanks the Examiner for noting the presence of allowable subject matter in this application. Claim 47 has been re-written into independent form

including all of the limitations of any intervening dependent claims. Withdrawal of the objection of claim 47 is respectfully requested.

CONCLUSION

Applicant believes that all pending claims are allowable and a Notice of Allowance is respectfully requested. The amendment was made to expedite the prosecution of this application. Applicant respectfully traverses the rejections of the amended claims and reserves the right to re-introduce them and claims of an equivalent scope in a continuation application.

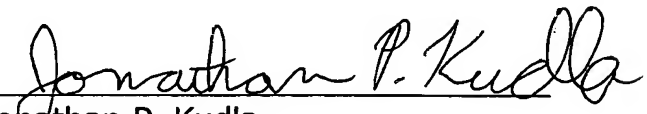
FEE DEFICIENCY

The Commissioner is authorized to charge any required fees, additional fees, or credit any overpayment to Deposit Account 50-2207.

If the Examiner believes that a conference would be of value in expediting the prosecution of this application, he is cordially invited to telephone the undersigned counsel at the number set out below.

Respectfully submitted,
PERKINS COIE LLP

Date: May 27, 2005



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